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Subject:	Gasco Groundwater Modeling Conference Call Follow-up – Summary of Approaches for Sensitivity Analyses and Particle Tracking Simulation
Date:	Wednesday, August 31, 2016 12:45:59 PM
Attachments:	Gasco_Source_Control_Modeling_Schedule_20160830.pdf

Dana,

The following email is provided on behalf of Pradeep.

Hello Dana,

Thanks to the DEQ and EPA teams for attending the conference call on Monday 8/29. As discussed during the call, we are providing this summary of the approaches discussed (grouped by topic) and a revised schedule (attached PDF).

Sensitivity Analyses

DEQ previously agreed that the following three sensitivity analyses will be evaluated upon finalizing model calibration (e-mail from Pradeep Mugunthan to Dana Bayuk on 2/19/2015):

1. Basalt no-flow boundary condition
2. U.S. Moorings no-flow boundary along the North-west
3. Far-shore general head boundary

During our call on Monday 8/29, DEQ agreed that the basalt no-flow boundary condition has been evaluated over the course of model calibration. This was accomplished by performing a series of model simulations with different flows from the basalt entering the lower and deep lower alluvium in the model and selecting an appropriate flow that best represents flow from basalt to the Alluvium WBZ. Therefore, this sensitivity analysis has been completed.

For the U.S. Moorings no-flow boundary condition, we confirmed the approach that we previously agreed to in the 2/19/2015 e-mail. In summary, NW Natural will perform steady-state model simulations with and without HC&C extraction and identify the maximum difference in the model-predicted alluvium WBZ water levels along the U.S. Moorings no-flow boundary. The steady-state simulations will be done for both the Phase 1, Step 6 period and the February-March 2016 wet period.

For evaluation of model sensitivity to the far-shore general head boundary, stead-state simulations will be conducted for the Phase 1, Step 6 and February-March 2016 wet periods with an increase in the far-shore general head boundary head necessary to produce a flow of 350 gpm entering the model domain. The 350 gpm flow rate was identified as a reasonable upper bound flow along the extent of the far shore boundary in the Model Update Report (*Revised Final Hydraulic Source Control and Containment System Groundwater Model Update Report, prepared by Anchor QEA, August 2014*). The model-predicted heads from the two simulations will be compared to the corresponding heads in the base case runs. The far-shore general head boundary flows were approximately 220 gpm and 169 gpm for the Phase 1, Step 6 and February-March 2016 wet period transient calibration runs respectively.

Deep Lower Alluvium Particle Tracking Evaluation

NW Natural reviewed the differences in groundwater level elevations from wells located along the upland

model boundary relative to the Serfes average river stage over the period when Phase 2 testing was conducted. Based on the observed water level differences, February 2016 is proposed as a suitable period for particle tracking evaluation because this time window showed higher gradients from upland to the river (Figure 1 below). During the call we also reviewed observed water levels in the deep lower alluvium wells and concluded that the difference in water level relative to the river stage does not show a significant seasonal pattern compared to the upland model boundary wells. DEQ agreed to NW Natural's proposal to use average conditions over February 2016 to run a steady-state simulation which will then be used to drive a particle tracking simulation. The particle tracking simulation will be set up by releasing particles from all model cells in the upland area of the deep lower alluvium. Model results will be presented as a plan view that shows particles captured by the HC&C wells and particles reaching the river in different colors. NW Natural will also explore the feasibility of developing a cross-section showing an individual particle track simulation.

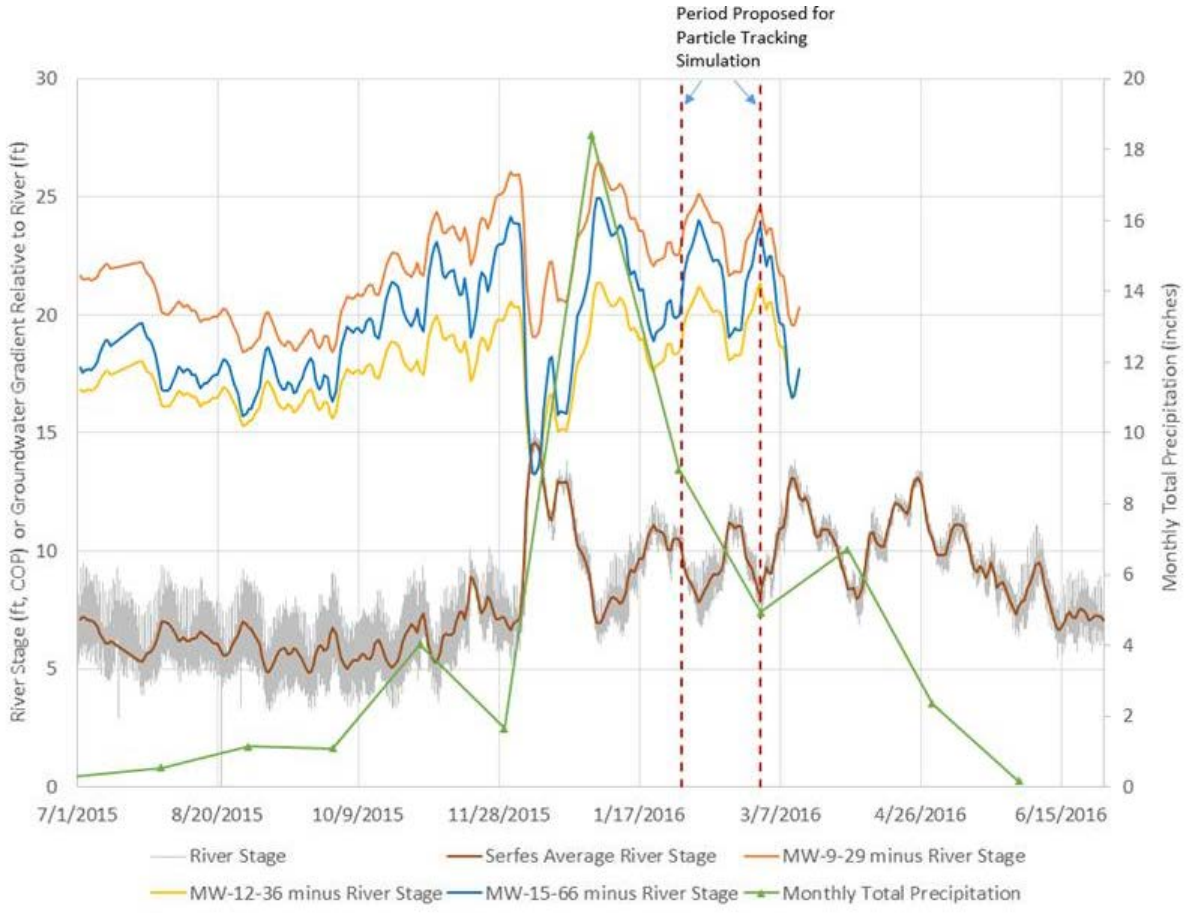

Figure 1. Observed Water Level Difference in Upland Wells Relative to River during Phase 2 Test Period

We have also updated the groundwater modeling schedule (attached PDF). As discussed over the phone this morning, to improve efficiency of the overall review and approval process and considering that the modeling team has been working closely with the DEQ and EPA teams throughout the model development and calibration process, we are proposing to submit a final report after we receive comments from DEQ on the draft report rather than an intermediate report that undergoes an additional round of review as proposed in Steps 12 and 13 in the draft schedule that was provided to DEQ earlier this year (e-mail from Jen Mott to Dana Bayuk on May 1, 2016). The updated modeling schedule (attached PDF) shows final

report submission (Step 11) after agency comments on the draft report (Step 10). If necessary, our responses to agency comments on the draft report and any specific concerns that need resolution prior to developing the final report can be addressed over conference calls. We have also included an additional follow-up step (Step 13) after DEQ review of the final report (Step 12) to resolve any outstanding issues.

Please confirm that the scope of the analyses laid out above is consistent with the discussion during our conference call on Monday (8/29), and that the updated schedule is consistent with our telephone conversation this morning. Upon receiving confirmation NW Natural will complete the sensitivity analyses, and particle tracking simulations as well as model validation over the Phase 1, Step 5 period. NW Natural will then submit a modeling report to DEQ documenting model development, calibration, validation, sensitivity analyses and particle tracking simulation per the updated modeling schedule.

If you have any questions or concerns please let me know.

Thank you.
Pradeep

Thank you,
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